

Role of Neuroimmunology to Better Understand the Interactions of the Nervous System and Immunology during Development, Homeostasis, and Response to Injuries

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Abstract

This article has focused on the combined field of neuroscience that is based on the immunity and nervous system. It is also known as neuroimmunology and it makes a positive and effective impact on medical science. This paper has tried to elaborate on the concept of neuroimmunology and also discussed the connection between the nervous system and the immune system. It has been seen that development, homeostasis, and the response to injury are the major factors that have the interconnection between these major complex systems. This study has also focused on the immune response of the body and evaluated its neurological aspect with it. There are various syndromes and diseases that are only identified by the neuroimmunology study. This field also helps to find serious disorders that support the individual to get treatment earlier. The severe neurological injury is affecting a person the major treatment for this is to avoid brain ischemia, which is beneficial for the neuroimmunology deficiency of a patient. Different kinds of neurological treatments are developed for a patient that is beneficial for them to overcome the situation of neurological disorder. On the other hand, this study has used a secondary qualitative method to get extract outcomes from the study and this process also helps to provide the relevant conclusion for the study. Applying this method helps to gain more knowledge on neuroimmunology and understand the value of this field.

Keywords

Acute disseminated encephalomyelitis, acute disseminated encephalomyelitis, GABA, Guillain-barre syndrome, homeostasis, immunity system, nervous system, neuroimmune system, Neuroimmunology, passive immune system, pathogenic microorganisms, self-immunity system.

INTRODUCTION

Neuroimmunology is one of the combined fields of neuroscience and this study generally focused on the immunology and nervous system. Neuroimmunology is highly connected with the immune system and it can provide better knowledge and increase the understanding capacity of the interaction between two complex systems such as immunology and the nervous system. Immunology is the study based on the immunity system and it is one of the essential branches of biological science and medicine. The immunity system protects the body from disease, infections, and viruses. This system is also connected with the function of the body and those functions are highly interconnected with the nervous system. This study will highlight the connection between the immunity system and the nervous system and also try to better understand the interaction of immunology and the nervous system during the response to injuries, homeostasis, and development. In the modern era, neuroimmunology fields make a huge impact on medicine and neuroscience which can also detect critical issues and try to connect the actual reason for disease. This study will further discuss the immune response of the body and its

interrelation with neuroimmunology. It helps to understand the immune response of the body and its connection with the immunity cells and sensory neurons. In this context, substances p, Glutamate, and γ -aminobutyric acid play a major important role and it has a major connection with neuro-transmission as well. This research paper also shed light on the impact of the treatment process through neuroimmunology and its benefits in medical sectors. It can be said that neuroimmunology is one of the innovative fields that help to diagnose the disease and also find the root of the disease. Nowadays, scientist prefers this field for their research and they get some essential and new information from the neuroimmunology compiled field. That information helps medical professionals to provide better treatment to their patients and also assists to meet the medical outcomes as well. Accordingly, this specific research study will further discuss the barriers of neuroimmunology and its effectiveness on the interactivity of the nervous system and immunology.

LITERATURE REVIEW

Role of neuroimmunology and its connection with the biological field

Neuroimmunology is one of the studies that is based on the immunity system and nervous system. The nervous system has a major connection with the immunity system and this study always forced on making the interaction between two complex systems. It can be stated that the nervous system is the process that helps to maintain the balance in the body and also support doing activities and other work [1]. On the other hand, the nervous system also supports the other functions of the body and provides sensation to the body. Accordingly, there are various kinds of activities that are only conducted by the nervous system. Moreover, the nervous system has a primary connection with the brain and helps the individual make decisions, do work, speak, walk, listen, and learn.

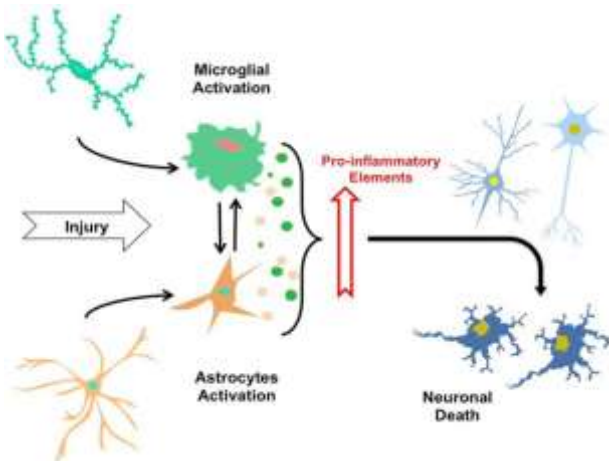


Figure 1. Neuroimmunology and its connection with the biological field (Source: 2)

The immunity system is the process that protects the body from disease, attack of viruses, and infections. The body's immunity system is made of different cells, proteins, and organs that always work together. In this context, antibodies, the lymphatic system, bone marrow, spleen, white blood cells, thymus, and the complement system are part of the immunity system [2]. When a human body senses an unknown and foreign substance or antigen, then the immunity system tries to recognize the substances and also tries to get rid of those antigens. Generally, B lymphocytes make the antibodies such as immunoglobulins and this antibody helps to lock the antigens from spreading. There is a long-term interaction between the central nervous system and the immune system that allows the immune system to attach to the rest part of the body to oppose the foreign substances from the pathogenic microorganisms and also empowers the nervous system to properly regulate and control the immune functioning process [3]. For example, it can be said that Guillain-barré is one of the rare syndromes that reduce the immune system and affects the entire nervous system of the body. Neuroimmunology is one of the fields that can detect

this kind of disease and provides a suitable suggestion for solving the issues. The nervous system is always responsible for maintaining homeostasis made by the neurons and connects the sense organ such as the skin, and eye to the brain. On the other hand, the immune homeostasis process regulates immune activation and maintains the balance under physiological conditions [4]. The immunity system and nervous system are the two main controllers of homeostasis. Molecules and immune cells are more requires for the sculpting circuitry and activity nervous system. On the other hand, the neuroimmune system always uses the complementary process based on the immune cess and sensory neurons that can able to detect and respond to harmful or noxious stimuli.

The immune response of the body with neuroimmunology

The neuroimmune system are responding to sensory neurons and immunity cells for detection and creating a response. Glutamate, serotonin, substance P, dopamine, and γ -aminobutyric acid (GABA) are helping to modulate immune responses. The realizing neurotransmitters are affecting entire immune system functions. Neuropeptides and endocrine hormones are helping to regulate the physiological functions of the body [5]. Innate, adaptive, and passive are the immune response of the body that are developed for protection. The innate immune system is referred to as the system which is an inborn system of a person.

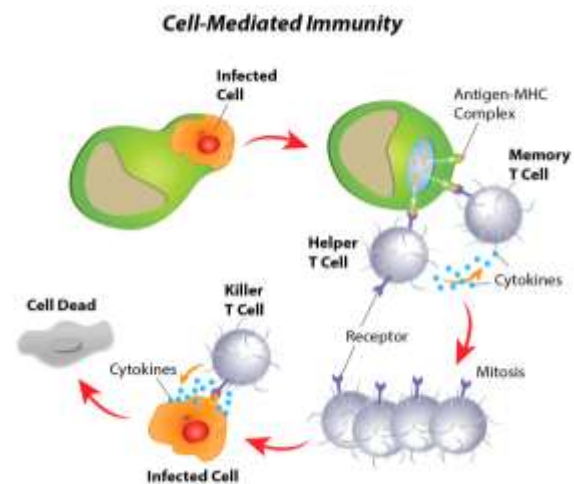


Figure 2. The immune response of the body to neuroimmunology (Source: 6)

This is beneficial for developing protection from antigens and creating a barrier in the body from harmful materials. The foreign invaders in the body are destroyed by adaptive immunity that is connected with specialized immunity cells and antibodies [6]. This is beneficial for preventing diseases in the future with the help of an Adaptive immunity system. This is also beneficial for eliminating pathogens for preventing their growth in the body. An adaptive immunity system is a slower-acting, long-lasting, and provides a

specific way of responding to the problem of the body. A passive immunity system is beneficial for ensuring antibodies for a disease are produced through the self-immunity system. The passive immunity system can be both artificial and natural; artificial passive immunity is achieved with fusion containing high concentrations of antibodies.

The immune response of the body is divided into four steps that are beneficial for ensuring the overall progress of the body. Encounter, attack, activation, and memory are the steps of the immune response of the body. Traumatic injuries are affecting the central nervous system creating paralysis and permanent disabilities of a person. The role of the immunity system after CNS injuries is difficult and multiple factors are developed for ensuring recovery after the injury [7]. The tissue damage is becoming bad due to immune cell-productive factors like free radicals, pro-inflammatory cytokines, and neurotoxic glutamate. The 7 components are helping to produce the immune system's white blood cells. thymus. lymphatic system, spleen, antibodies, complement system, and bone marrow. Neutrophils are the most responsible immune cell of the body that is helping to ensure heredity defences for overwhelming the bacterial defensive systems.

The impact of neuroimmunology on treatment

Neuroimmunology is gaining an important role in health that is beneficial for supporting neural development, homeostasis, and plasticity for modifying a person's behaviour. Weakness, walking problems, and difficulties in speaking and swallowing are the effect of neurological disorders that can be developed in a person. Guillain-Barré syndrome is a rare disorder of the body that is attacking the body's immunity system. This is creating weakness and tingling in the hand and feet as symptoms in the body. Acute disseminated encephalomyelitis is creating a widespread attack in the brain and spinal cord which is damaging the myelin, a protective cover in nerve fibres.

Nausea and vomiting, confusion headache, are the signs of acute disseminated encephalomyelitis (ADEM). Multiple sclerosis is creating nerve damage that is disrupting communication in the body and brain. Vision loss, pain, fatigue, and impaired coordination are seen as an effect of this disease [8]. Neuromyelitis Optica is a rare condition where the immunity system is damaging the nerve of the eyes and spinal cord. Irregular antibodies bind with proteins in the central nervous system and cause damage to the immunity system of the body. Transverse myelitis is developing inflammation in both sides of the spinal cord. Transverse myelitis is providing interruption to the messages that the spinal cord nerves send throughout the body. The fight against infection is developed against pathogenic microorganisms that are helping to regulate immune functioning in the nervous system [9]. The severe neurological injury is affecting a person the major treatment for this is to avoid brain ischemia, which is beneficial for neuroimmunology deficiency in a patient. Different neurological treatments are developed for a patient that is beneficial for them to overcome the situation of neurological disorder. These treatments are medicine provided with drug pumps, Spinal cord stimulation, Deep brain stimulation, Rehabilitation after a stroke, and Spinal surgery. The nervous system is developed with the brain, spinal cord, and a difficult networking system of nerves. Anti-inflammatory drugs, corticosteroids, immunosuppressant drugs, pain-killing medication, and physical therapies are helping to treat autoimmune diseases. The suppression of immune function is affected by chronic stress. On the other hand, different mood issues such as depression, and bipolar disorder and also different behavioural issues gained from illness such as brain tumours, traumatic brain injuries, post-traumatic stress disorder, and autism are developed with the neuroimmunology disorder. Neurological deficiency can be developed in a person due to genetic disorders, lifestyle problems, infections, nerve injury, or spinal cord injury.

Barriers of neuroimmunology to knowing the interactivity of the nervous system and immunology

The natural barriers developed for neuroimmunology are skin, tears, mucous membranes, mucus, earwax, and stomach acid. Normal flow in the urine is able to remove microorganisms from the urinary tract. The blood-brain barrier is developing information that is beneficial for unregulated changes in immune cells and blood. This is helping to ensure the dynamic, interactive, and adaptable interface that are creating a connection between the immunity system and CNS. An unregulated leakage developed through BBB is not able to ensure any immunoreactive substance for blood and the brain that is developing immunoglobulins [10]. The development of hypothalamic damage is created due to disruption in BBB. Bacterial endotoxin is creating brain damage and tissues that are ensured with the release of an endogenous substance.

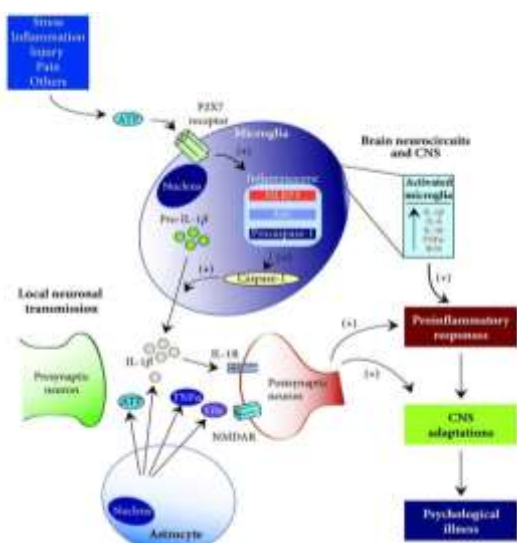


Figure 3. Impact of neuroimmunology on treatment (Source: 8)

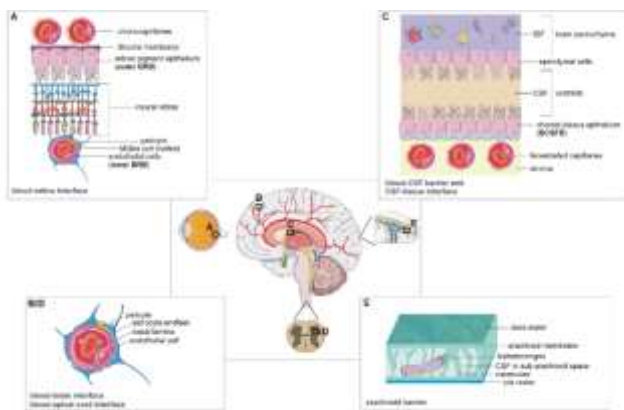


Figure 4. Barriers of neuroimmunology to knowing the interactivity of the nervous system and immunology (Source: 10)

BBB disruption is created by multiple sclerosis, vascular dementias, neurotrauma, and stroke and all these are involved with neuroinflammatory events. Neurotoxic effects are created that are effective for the protection of the brain and create difficulty in complicated processes such as movement, thought, and memory. Electroencephalogram (EEG), Functional magnetic resonance imaging (fMRI), Magnetoencephalography (MEG), Transcranial magnetic stimulation, Photon migration tomography, and Further Reading are helping to understand the overall development of the brain [11]. Infections, Trauma, Degeneration, Tumours, Blood flow disruption, Structural Defects Autoimmune disorders are the factors that are affecting the nervous system. Viruses, bacteria, and fungi are protected from the different immune responses that are gaining physical and chemical barriers, non-specific innate responses, and specific adaptive responses are the barriers to the immune system. The skin, mucous membranes, and endothelial are developed as a physical barrier that is preventing microbes from protecting potential sides of infection. The primary barrier for infection is developed in the skin which is entirely covered with dead cells that are able to carry bacteria and different pathogens with them.

METHODOLOGY

Research methodology is a process that has various steps and all research study follows those steps during the research. In this context, the research design, research approach, philosophy, data collection, and data analysis has explained as per the study requirements. Research philosophy is one of the wide range of subjects that generally depends on the topic assumptions. Researchers used the philosophy as per their knowledge and topic assumption and use the philosophy as per the requirement of the study [12]. This study has used positivist research philosophy and this is highly structured. This process has the opportunity to understand the research assumption. On the other hand large sample size also helps to recognize the outcome of the study. This research study has chosen the secondary qualitative data analysis and data collection method. This method allows getting raw data on

neuroimmunology and also helps to use the data in the research study as per the development of the research process. Accordingly, the research study has used an inductive approach to create a proper conclusion for the research paper [13]. The secondary qualitative process is much easier than other processes and helps the researchers to draw out the point information for the research work. On the other hand, this study has used qualitative research study, and this process is divided into four parts such as phenomenology, ethnography, case study, and ground theory basically included in the segments of research methodology. In this context, it can be said that this article paper has used case studies that usually use different kinds of information from different sources. Neuroimmunology is a versatile chapter and it is easy to collect data from known sources. The secondary qualitative methods provide a large amount of information that is always available on the internet [14]. Google scholar and google search engine provide opportunities to get the data easily by maintaining an ethical manner. Moreover, this method of research does not mandatory high effort and technical skill. This is one of the most convenient and budget-friendly processes. The secondary qualitative method uses the data from electronic journals, newspapers, articles, a journal published by the authors on the internet. This is a worldwide source that helps to acquire more data and analyse the data perfectly. One of the biggest advantages of this method is, this method has not required human participation in the research work. It assists to reduce the budget and reduces the chance of getting fake data. From this research, the method helps to gain knowledge and experiences on the research ground that helps the professionals to apply the experiences in their future research work [15]. From this research study, it has been known easily that neuroimmunology has a logical connection with homeostasis, development, and response to injury. It also makes a prosperous impact on the modern field of treatment. Medical professionals and researchers use this field to recognize the disease and gain knowledge on this particular subject matter. Those data increase the value of research work and it can be said that this process helps to better understand the connection of complex systems.

DISCUSSION

The nervous system and immunity system both are attached to each other and from the above mention study, it can be stated that both can participate in the development. Body and brain development is crucial and needs a strong immunity system. These system helps to prevent disease and protect the body from foreign substances [16]. Accordingly, the nervous system helps to activate the developed body and also assist to provides the ability of learning and make a decision. On the other hand, homeostasis is one mind the self-regulating process that can able to maintain internal stability and also adjust as per the changes of some external conditions such as body temperature. The normal body temperature of a human is 98.6 degrees F. though there are

various factors that can affect the value such as hormones, metabolic rate, disease, and many more [17]. The nervous system controls the constancy of the organism in the internal environment and also provides the proper chemical circumstance. On the other hand, immunity system regulates the networking system which allowed for the maintenance of the immune balance under standard biological condition. In neuroimmunology, response to injuries is one of the factors that help to understand the interaction between nerves and the immune system [18]. Where the nervous system helps to feel the injuries by inflammation, pain, and other processes. At that time specialized nerve cells transmit the message to the brain and individuals feel the injury in their bodies. Accordingly, inflammation happens when tissues are injured by toxins, heat, trauma, bacteria, and other causes. In that case, damaged cells secrete chemicals such as prostaglandins, bradykinin, and histamine. Rapidly released anti-inflammatory mediators such as chemokines, cytokines, growth factors, and other substances help to mitigate the injury as well [19]. From this study, it has been seen that neuroimmunology makes an innovative impact on the modern treatment process.

Different mutations and development are achieving the growth of the human central nervous system (CNS) which is regulated by intrinsic and extrinsic factors. Modulation of the development that is helping to achieve the proper development and homeostasis of CNS. Microbiota in CNS and the pathogenesis of CNS disorders are helping to develop different diseases such as Alzheimer's disease (AD), multiple sclerosis (MS), Parkinson's disease (PD), and gliomas. Different automotive activities are developed in the system that is helping to achieve progress in the body with thinking, reading, feeling, and walking; brain growth and development are helping to the survival of the body. Anatomical and physiological barriers are ensuring defensive growth against different pathogens. Different static and dynamic studies are helping to produce better growth for the research that is gaining detailed CNS immunity cells against the microbes for the maintenance of neural function. The CNS immunity diagnosis is developing with homeostasis, injuries, infectious diseases, and aging. A poor regenerative capacity is developed with CNS that is able to achieve proper development and growth that are altered by aging and neurodegenerative diseases like Alzheimer's. Different physical activities are helping to ensure the proper growth of the body that are also beneficial for the improvement of memory and the reduction of anxiety or depression of a person. Neurological development is helping to produce growth that is beneficial for promoting an essential improvement that is helping the patients to understand pain from different biological and physiological perspectives. Genetic disorders, congenital abnormalities, infections, and lifestyle health problems also including malnutrition, brain injury, spinal cord injury, or nerve injury are developed through neurological function. Lectical impulses and different chemical signals to transmit information developed

between different areas of the brain, and between the brain and the rest of the nervous system are essential parts of learning and brain development. Synaptic plasticity, including long-term potentiation (LTP) and long-term depression (LTD), underlining the memory in the nervous system are developed for the pathogens encountered by the body. Data regarding the interaction of immune cells and neural cells are developed in a limited way except for the microglia. Different rare nervous issues are developed with the affected functions aiming towards the neurooncological issues. Detection of both internal environment and external environmental changes in the body, Integration of Information, and Conduction of Information, respond to stimuli are the major functions of the nervous system that are essentially building growth in the body. The spinal cord, the medulla, the diencephalon, the pons, the midbrain, the cerebellum, and the cerebral hemispheres are the major components of the nervous system [20]. The different complex nervous systems, spinal cord, and brain are the main three organs that are ensuring an important role in the nervous system. The sciatic Nerve and Sciatica are used to be the largest nerve in the body, the roots of the nerve is started from the lower back and run down back of the each leg. Sensory, motor, and interneurons are the three types of neuros that are important for the human body. The optic nerve is an important nerve that is developing responsibility for vision. Sensory input, integration, and motor output are the main functions of the body that is important for the nervous system for controlling and communicating different information throughout the body. The connection between the brain and the immune system is developed with tissue that is covering the brain and spinal cord. Detection of injuries, infections, or any diseases and inflation is developed for gaining immunity from this. Psychoneuroimmunology is the study that is helping to study different issues and behaviours, endocrine function, and neural-immune processes. During times of depression and pain, an effect of general cognition and brain responses are provided a signal that is transmitted for creating a connection between the immunity system and mental health. Microglia is defined as the most dominant immunity defence that is connected with brain cells.

CONCLUSION

The above study has based on neuroimmunology and an important branch of neuroscience. This is one of the ways that can able to create a connection between the nervous system and the immunity system. Both are complex systems in the body and it has been seen that both systems are interconnected with each other. This study highlights the role of neuroimmunology and its interaction with immunology and the nervous system during development, response to injury, and homeostasis and development. From this study, it has been observed that the nervous system and immunity system both maintain their responsibility in body development and homeostasis and also help to respond to injury. Secondary qualitative data analysis methods are used

for completing the research that is essential for aiming toward better growth and development. The research work is completed by developing different way towards neuroimmunology development that is beneficial for processing success in the research development. Home statistics are majorly controlled with the help of the nervous system. The monitoring, response, and regulation of different systems are developed with the human body and other organs. These are helping to provide better growth in the developing infection in the body with neuroimmunology difficulties in the body. A tightly controlled regenerative process is developed with lost myelin that is highly abundant for the completion of neuroimmunology development. The permeability is developed with OPC which connected angiogenesis and blood–brain barrier permeability. The nervous system of the body is helping to connect with the communication system and helps to ensure overall growth.

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